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► **To cite this version:**

Justin Larouzée, Aurélien Portelli, Eric Rigaud, Didier Delaitre, Sébastien Travadel, et al.. Innovative and Immersive Crisis Management Training Device. 33rd European Safety and Reliability Conference, Sep 2023, Southampton (U.K.), United Kingdom. pp.2380-2387, <10.3850/978-981-18-8071-1_P135-cd>. <hal-04327317>

HAL Id: hal-04327317

<https://minesparis-psl.hal.science/hal-04327317v1>

Submitted on 6 Dec 2023

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Innovative and immersive crisis management training device

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Accidents such as Fukushima Daiichi demonstrates the limits of crisis management training. During a crisis, decision-makers may rely on their experience or the application procedures, but they often need creative skills. Indeed, a crisis is characterized by incomplete or contradictory information, changing goals, and time pressure. Thus, decision-makers must find solutions in an emotional context of stress and fatigue. Traditional crisis management training relies on return of experience and the drill procedures in pre-identified scenarios (theoretically explained or in serious games). This have contributed to reinforcing organizational response but it's not adapted to develop creativity. To do so, we designed and tested an immersive training device to disrupt learners' cognition, making them aware of the importance of their senses, emotions, and representations in the decision-making process. During the session, learners must make decisions based on what surrounds them. Before exiting the room, they must evaluate their performance (which is impossible since the sequence is designed to be meaningless). The debriefing showed how difficult it was for the learners to admit the absurdness of the exercise, as revealed by the strength and ingenuity of their rationalization mechanisms. Our ambition was to complement theoretical lessons. However, first results have inspired a 3-5-year research program to study the articulation between lived experience, feelings, memory, and self-narrative in the face of a crisis.

Keywords: Crisis management, Immersive training, Emotions, Self-narrative.

1. Introduction

The potential for crisis is a common and natural phenomenon in all complex systems, whether natural, anthropogenic, or artificial (Morin, 1968, 1977, 1984). The crisis is a temporal period that

begins when the system perceives that the thresholds of acceptability of the negative consequences of disturbances are exceeded and ends with the re-establishment of a state of equilibrium within the system. Organizations and territories have progressively equipped

themselves with crisis management systems that structure prevention, preparation, and business continuity actions (Alexander, 2012). These systems include plans (alerts, evacuation, rescue) and training curricula so that agents can adopt appropriate behavior during a crisis.

The definition of plans and training is primarily based on lessons learned from past crises. This leads to a relative vulnerability to situations that are unprecedented in their nature, intensity, or scope (Gisquet & Borraz, 2020). This problem is all the more important because the frequency of this type of situation will likely increase due to globalization, climate change, the increasing complexity of industrial systems and supply chains, or tensions between states (Goldin et al., 2014). This leads to the need to consider two types of crises and two systems of competencies. The first is related to crises whose nature and magnitude are similar to situations that occurred in the past. In a degraded context, crisis management is based on the implementation of tasks learned during training. In this case, the situation is a crisis, but the actors are not "in crisis" because they know the tasks they must implement and practice them regularly; for practical purposes, we propose to label this as "type 1 crisis". In the second case, in order to deal with a new situation, the actors must demonstrate creative abilities to develop a diagnosis, correct insufficient or false knowledge, and challenge an established or sacralized order to recognize the nature of the evil and act accordingly in a context of uncertainty, fear, and controversy (Morin, 1984). In this case, we propose the label "type 2 crisis".

Consequently, training in crisis management must, first and foremost, develop the knowledge, know-how, and interpersonal skills related to the various plans to be implemented during a crisis. Thus, lectures and practical applications must be provided so that learners (whether in initial or continuing education) master the fundamental concepts, the cause-and-effect mechanisms that can occur during a crisis, and the technical and non-technical tasks that must be implemented. These competencies allow the development of the ability to deal with events for which experience provides sufficient knowledge to develop standards of prevention and preparation for crisis management (type 1). Crisis management training must also develop creative skills to enable the

actors involved to identify when their system of actions (representations, rules, resources, information, time, or skills) is not or is no longer in line with the current event (type 2). These creative skills ultimately serve to invent new responses based on representations that come close to the exact nature of the event and to mobilize the elements available to deal with it to regain control. Traditional educational approaches allow for the development of Type 1 crisis management skills but need to be more expansive in developing Type 2 crisis management skills (BEA, 2012, p. 207; Castagnino & Fayeton, 2021). One likely cause is that the psychological, biological, hermeneutical, and cultural underpinnings that structure the creativity skills needed in Type 2 crises, and their pedagogical modalities for development, still need to be better understood and under-researched.

In order to meet this training need, we first define a theoretical framework for the study of decision-making through the prism of emotions and imaginaries (part 2) before presenting the design and experimentation of a prototype immersive pedagogical device aimed at developing type 2 crisis management skills (part 3). Finally, the article presents and discusses the results of this first experiment (part 4).

2. Emotion, imaginary and decisions

This section presents two parts of our multidisciplinary theoretical framework. First, the one that allows us to articulate emotions, rationality, and decision (2.1). Then, the one that allows us to account for the existence of an imaginary of control (2.2). Each of these parts allows the elaboration of design hypotheses for the immersive device presented in part 3.

2.1. Emotions in decision making

At the end of the introduction, we stated that traditional approaches to crisis management training are largely limited in developing Type 2 crisis management skills. This fact is probably not independent of the history of scientific approaches to emotion: *"During most of the XX^e century, in the neuroscience laboratories, emotion was mistrusted. Emotion, it was said, was too subjective. Emotion was too evanescent and vague. Emotion was at the extreme opposite of reason, human capacity by far the most beautiful,*

and reason, it was presumed, was entirely independent of emotion. [...] Finally, not only was emotion not rational, but even studying it was probably not rational either." (Damasio, 2002; pp. 46-47, our translation).

However, according to Damasio (2001, 2002, 2005), emotions play an essential role in the ability to program one's actions in the future. This capacity underpins, among other things, respect for social rules, moral conduct, and the ability to make decisions in complex situations likely to impact survival. Indeed, the brain anticipates the future and forms action plans based on emotions that influence the options available for decision. The neural circuits underlying the perception of emotions are located in the regions of the brain where signals from the body are projected and integrated. The perception of emotions is linked to the sensory information coming from the mental representation of the body, updated at each moment. The coincidence of the sensory perception of an external object and a perceived internal state gives the object, or the event, a "quality" (good or bad), depending on the information coming from the body. Emotions thus have a cognitive value since the capacity to perceive emotions allows us to evaluate the quality of the relations between the organism and the objects (concrete or abstract). Damasio's work has thus contributed to accepting the idea that decision-making goes through two complementary channels. The first triggers in the brain of the decision-maker are a representation of the situation, options for action, and the anticipation of the results of his action. Reasoning strategies can operate on these representations to produce a decision. The second pathway, parallel and simultaneous, triggers the activation of previous emotional experiences that occurred in comparable situations. The recall of the related emotional material influences, in return, the decision process by drawing attention to the representation of future consequences or by interfering with the reasoning strategies. This emotional pathway can even lead directly to a decision. The use rate of each pathway, alone or in combination, depends on the individual development of the person, the nature of the situation, and the circumstances.

The first ambition of the pedagogical device we have designed is to lead the learner to recognize the existence of the emotional path in the reasoning strategies. This individual and collective recognition is fundamental in type 2 crisis management. Indeed, still following Damasio, we consider the emotions intrinsically rational (Damasio, 2005; p. 159) and favor results that could have been obtained logically. The body provides fundamental content to mental representations. It constitutes the frame of reference for our representation of the world and our relation to it. From the above, we draw a first design hypothesis:

Design Hypothesis #1: A teaching device targeting type 2 crisis management skills must be based on the mobilization of the whole body and senses to activate the emotional decision pathway. It must also address a particular form of imaginary we call *imaginaire de maîtrise*.

2.2. *Significations imaginaires and imaginaire de maîtrise^a*

According to Castoriadis, the *significations imaginaires sociales* refer to the norms, values, myths, representations, beliefs, traditions, and projects common to a given society's individuals. It is these creations that hold together the social edifice. In return, the psychic existence of the individual only makes sense by referring to the *significations imaginaires* created by society. In this way, the imaginary's two dimensions are linked, one individual and the other collective. Castoriadis considers *significations imaginaires sociales* to be the product of the anonymous collective imaginary. *Significations imaginaires* constitute an "indefinite bundle of interminable references to something else" (Castoriadis, 1975, p. 332 ; our translation), which refers to significations and to non-significations. All that society can seize or perceive is in that signification investment. For the author, it is because it is possible to grant a signification to all things that a thing can find itself deprived of signification or to be insignificant, even absurd: "The absurd can appear only from the absolute requirement of the signification" (Castoriadis, 1975, p. 320 ; our translation).

^a We kept these concepts in French as they are hard to translate without altering their meanings.

Significations imaginaires' role is to define identity, relation to the world and to the objects which populate it, needs and desires. Castoriadis specifies that "the institution of the society is each time institution of a magma of *significations imaginaires sociales*, that we can and must call a world of meanings" (Castoriadis, 1975, p. 480, our translation). Without these meanings, there could be no human world or culture, and everything would be chaos. It is by producing this magma of meanings that each society creates a world of its own and gives meaning to the activities undertaken by the human beings who make up the society. Since we are particularly interested in crisis management in industrial organizations, we focus on a particular form of *significations imaginaires* we call *imaginaire de maîtrise*. It refers to a belief in the possibility of a deterministic reduction of the risks that threaten individuals, limited to the level of each individual by his or her knowledge and understanding. This creation of meaning means believing and making people believe in the power and effectiveness of the devices deployed to protect workers from dangerous phenomena (Portelli, 2022, 2023). The study of type 2 crises such as the crash of flight AF447 (BEA, 2012) or the Fukushima nuclear accident (Guarnieri & Travadel, 2018) highlights the fact that the actors involved in their management are confronted with a collapse of their *imaginaire de maîtrise*, pulverizing in the process their system of values and beliefs, a source of stability and security. From the above, we draw a second design hypothesis:

Design Hypothesis #2: An instructional device targeting Type 2 crisis management skills must shake the learners' *imaginaire de maîtrise*. To do so, it must include an absurd dimension.

3. Educational device for type 2 crisis management

In order to respond to the limitations of current type 2 crisis management training devices, we have designed an immersive pedagogical device intended to show the importance of lived experience and the emotions it arouses in the decision-making process (design hypothesis n°1), as well as the place in the construction of the meaning of *significations imaginaires*, in particular in the event of the collapse of the imaginary of control (design hypothesis n°2). This part presents the context of the creation of

this device (3.1), describes the technical object and the audiovisual sequence conceived and used (3.2), and the pedagogical protocol imagined to reach our pedagogical objectives (3.3).

3.1. Context of realization

The immersive pedagogical device was designed and tested by the *Centre de recherche sur les Risques et les Crises* of Mines Paris - PSL in 2018 as part of a week-long course on crisis management and extreme situations for an audience of engineering students. The imagined exercise consists in immersing the learners in an absurd audiovisual environment where they are asked to make a series of choices and then a decision. The choices concern the signs perceived in the audiovisual sequence projected on the walls of a cubic immersive space (see 3.2). The final decision is based on the number of "correct answers" participants think they have given (see 3.3). In addition, participants are subjected to a form of pressure to act through the evaluation context in which the exercise is presented. The immersive exercise and its debriefing took place over half a day, inserted into the training week. All 18 learners were divided into groups of 5 to 8.

3.2. Description of the device

In order to concretize the design hypothesis n°1, an immersive audiovisual device has been designed. It consists of a closed projection room with four projection screens measuring 3 meters wide and 2 meters high. The images are projected from the outside by 4 video projectors. The sound is diffused by five speakers and a subwoofer (cf. Fig 1).

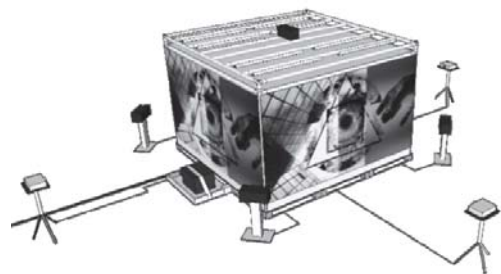


Fig. 1. Immersive audiovisual device.

In contrast to the quest for realism usually encountered in serious games or computer simulations (e.g., flight simulators, use of virtual reality) for training purposes, the environment in

which the participants are immersed is an artistic creation. This discrepancy creates an absurd situation and a contradictory environment where the interaction between the subjects and their environment tends to provoke discordant reactions (Dewey, 1993; p. 171). Using an artistic creation also removes the content from any judgment as to its realism.

The 15-minute video is based on familiar visual and sonic textures obtained by shooting and sounding everyday objects, which are superimposed effects of symmetry, distortions, and video filters. The soundtrack is played constantly, but the dynamics and sound worlds vary. All sound and visual effects remain within the limits of leisure film production.

In order to concretize the design hypothesis n°2, we chose to induce an industrial context through a framing written and hybridized with the instructions of the exercise. Thus, the sequence opens with the projection of the following instruction: "You have just been sent to an industrial site at risk. Minor anomalies have been noted in the previous days. You are now in the control room. A visual signal [pictogram insert] will indicate when you should make a protocol decision by sliding an O or an Δ in your envelope, according to the geometrical dominant found in what we have just seen. It is colored according to the color temperature found. The site manager points out that the geometric dominant Δ is generally found when the sound threshold emitted by the infrastructure that can be consulted on your control screen is close to or above 30 dB. Once the type of protocol has been inserted into your envelope, you cannot change this choice [our translation from French]". Control indicators (frequency and sound amplitude with a threshold set at 30 dB) and digital data (digital clock type) are projected throughout the experiment on one of the screens to reinforce the industrial setting. On the other screens, a series of absurd visual plans follow one another, interspersed with seven "protocol" pictograms that indicate to the participants that they must make a choice.

The video presents a first phase (of about six minutes), which allows habituation. Then, the visual and sound environment becomes more chaotic, the geometrical forms less discernible, and the color temperature more challenging to distinguish. The sequence of "protocol" pictograms gradually accelerates. Some sounds are difficult to

identify, while others are played with precision. The control indicators on the central screen are sometimes correlated and sometimes uncorrelated with the actual sound dynamics. The rhythm and the sound universe can also appear in connection or not with the images. The use of infra bass reinforces the emotional impact of the sequence. A sequence throughout the video can evoke the previous ones in an altered form, associated with a dominant color and/or a distinct sound atmosphere. Snippets of regularities are thus suggested, without it being possible to conclude objective rules of association between type of images, geometric dominant, color dominant, and sounds.

3.3. Training protocol and self-narrative

The immersive sequence is framed by a pedagogical architecture, partly theatricalized, before, during, and after. Without this extended architecture, the immersive experience would have no educational value. Before entering the device, instructor "A" gives participants information about the exercise and informs them that they will be assessed. A facilitator, "B," accompanies them to the immersive device. In an airlock, participants are called by a third facilitator, "C," to receive seven numbered and nominative envelopes, two series of plastic geometric shapes (triangles and disks) in three primary colors. Each participant is invited to join speaker "B" inside the device. The participants place themselves freely in the enclosure to see at least two screens. The sequence begins (see 3.2). When an injunction to choose (cf. figure 2) appears, each participant must insert in an envelope a choice concretized by a colored geometric shape. At the end of the sequence, the last instruction implies that the participants must stay in the device or exit if they think they have a specific success rate in the test. Facilitator "B" stays with the participants until they leave the room. He does not intervene during the sequence and notes those who decide to stay or exit at the end. Once the final decision has been made and accepted, the learners return to the room where they are asked to write freely, in about five minutes, "how they experienced the exercise." This last step is fundamental and must be considered an integral part of the immersive experience. Indeed, the narrative is of fundamental importance in understanding and creating the meaning given by an individual to his

experience. According to Paul Ricoeur (1985), the narrative is a means of structuring temporal experience. In this respect, self-narration can be interpreted as an attempt by the individual to inscribe his or her existence in time. The narrative activity, by proceeding to a setting in the intrigue of the facts which follow one another in time, thus makes it possible for the individual to compose the framework of his lived life and give sense to the events which constitute its history. Once the stories are written, the learners are invited to share their writings and then comment on them freely. This time of sharing experiences makes it possible to become aware of the subjectivities that were mobilized for the choices and decisions; it also makes it possible to highlight the mechanisms for seeking congruence and defending, and justifying the decisions that were made (even though these are confronted with alternative realities, as diverse as the number of participants). The exercise ends by putting into perspective the theoretical contributions of the previous days of the training week on crises and extreme situations^b.

4. Results and discussion

This section presents the results of this first experimentation of the immersive device. Based on the analysis of the stories, it is possible to establish that the main pedagogical objectives were reached (4.1). However, this first experimentation also allowed us to establish areas of improvement in the protocol and the device. These perspectives are presented in the discussion section (4.2).

4.1. Restitution of the participants

Participants described a disturbing, even oppressive atmosphere with a "sense of urgency." Some associated this with the examples from the previous half-day sessions, expressing their feelings regarding "a real sense of danger and risk." One participant summarized: "the last two or three sequences were very short, and the sound and visual atmosphere was quite stressful, so I had to choose with some haste. I imagine here that the

idea was to destabilize us, and it is rather successful [our translation from French]."

The participants all made a choice when they were invited to do so. For this, they tried to associate shapes and sounds, sometimes also indicators. But basically, they did not formulate a "rule" that they would have discovered in the situation. The following excerpt expresses what each one was able to experience: "*the flashes and sounds left me very worried and so I chose the geometric figure and the color with my intuition and the feeling I had...* [our translation]".

We observed that the control screen was abandoned by most, even though it was effectively correlated with the soundtrack during the first few minutes of the sequence. The participants also affirmed the "obviousness" of their choices. Two excerpts allow us to grasp their certainty: "*A feeling of fear of doing the wrong thing quickly overtook me, especially during the passages of filling in the envelope. I was also confused about the purpose of the exercise and the choice to be made, which always seemed surprisingly obvious to me*" ; "*After some hesitation, I decided. The sequences went together without too much trouble afterwards, although I wasn't sure what to make of the volume indication* [our translation, our emphasis]".

Asked to make choices from contradictory information, participants systematically eliminated some signs (the sound, the image, the control screen, certain qualities of the images) to concentrate on others. The initial phase facilitated immersion in this strange universe and the subsequent acceleration introduced an element of haste that did not, however, call into question the foundations on which they acted. The final decision, based on a self-evaluation, allowed participants to test their certainties. We note that most of them formulated a "subjective" character to the choices, and that it is the preeminence of this evaluation criterion that led the majority of them to judge their choice sequences as "correct": "*at the end of the exercise, the request for self-evaluation surprised me because it seems to me that the choice of triangle/round and the choice of color are quite subjective. And as such, I feel that*

^b First part of the course was devoted to risk analysis methods used in industry and a reflection on engineering methods. Second part was devoted to the concept of *signification imaginaire sociale* and its

application in the Fukushima accident. Third part was devoted to the concepts of "sacred" and "scapegoat" illustrated with the sinking of *La Méduse* (1816).

all responses could be considered correct, which is why I stayed at the end of the exercise, despite deep uncertainty [our translation]."

Let us underline the profound reversal of the "value" of truth attributed to the subjective criterion, on the part of students experienced in logical reasoning of the hypothetico-deductive type, as practiced in their physical-mathematical training, and showing in their exchanges during the previous days, an assured positivism. Their answers were "correct" because they felt that they were, to the point of opposing their choices to the "objective" evaluation of which the exercise was supposed to be the object. Making learners aware of this fundamental point was the main objective of the exercise.

Finally, the participants were surprised not to exchange verbally among themselves, which was not forbidden to them (no instructions had been given in this sense) but which translates the internalization of the decision. However, a gestural and bodily communication was established, through exchanges of incredulous looks for example. One of the participants even explains that *"the presence of others was reassuring. We exchanged our astonishment, our questions. I now have the impression of knowing and recognizing these people who were with me, something connects us [our translation from French]"*. Here we find one of the driving forces behind the formation of groups in crisis situations, evident in particular in the case of the operators of the Fukushima Daiichi plant.

4.2. Discussion

In some respects, this first experiment exceeded the expectations of the designers. The richness of the self-narratives and debriefing had yet to be envisaged. As a result, it became clear that (1) the immersive sequence could be redesigned independently of the theoretical courses to produce self-supporting pedagogical engineering over one day (6 hours); (2) the presentation of the pedagogical objectives to the learners could be made more precise and the debriefing sequence more structured; (3) it would be interesting to design a measurement system to monitor the transmission of the elements taught. A second experiment was designed in accordance with these 3 points. At this stage, we propose articulating the discussion around this pedagogical device in four questions.

Is knowledge about the place of emotions, subjectivity, and imaginary representations useful to companies and crisis managers? We answer in the affirmative because crises do occur, some of which are likely to propel both the physical system and the actors in charge of managing the event out of any framework that has been anticipated (what we have qualified as type 2 crises). It is then necessary to train these actors to decide in an absurd environment devoid of meaning, which requires them to recognize and accept the subjectivity and the emotional part of their decisions. We consider these skills as components (if not prerequisites) of creative competencies that can be used to invent new ways of responding.

Are such skills currently lacking? To the best of our knowledge, we answer in the affirmative. We explain this lack, on the one hand, by the recent nature of scientific approaches to emotion (Damasio, 2001, 2002), by the positivist dominance of techno-scientific training and the power of the imaginary of mastery; on the other hand, by the limits of crisis management training devices, mainly oriented towards type 1 crises and training in the application of existing procedures (BEA, 2012; Gisquet, & Borraz, 2020; Castagnino & Fayeton, 2021).

Does our system effectively transmit/teach this knowledge? As it stands, it is not possible to answer in the affirmative. Although the first experimentation produced enthusiastic effects, it had yet to be the object of formalizing the competencies to be developed (since the immersive sequence was used to support the illustration of concepts taught during theoretical courses). Furthermore, we are developing a measurement system (hybrid questionnaires composed of Likert scales and open-ended questions to be administered before, immediately after, and long after the exercise; narratological analysis of the participants' stories). We also aim to test the pedagogical device on different audiences (initial training, continuing education, disciplinary profiles, and specialties). Finally, we could design other methods of evaluating the effects of our approach, for example, in association with a third-party organization that conducts crisis exercises or simulations. We could then subject participants with the same profiles (profession or experience) to these exercises, which would be divided in a double-blind manner

into two groups, one having received our training beforehand and the other "control" group that would not have followed it.

Is our device necessary? As the device was born from the need to illustrate theoretical notions, its perpetuation, and development require confirmation that it would be impossible to carry out the teaching we are targeting otherwise. Our ambition is, therefore, once we have validated a measuring system of the effects produced by the device, to carry out variability studies, with or without an immersive device (the same audiovisual content can be shown on a single projection screen or even on a simple computer screen) and with different audiovisual sequences.

5. Conclusion

The work of the CRC of Mines Paris - PSL on extreme situations, particularly the Fukushima Daiichi nuclear accident, has gradually led to the construction of a hybrid theoretical framework around the type 2 crisis. This theoretical framework borrows from philosophy, cognitive and social psychology, hermeneutics, and neurology. To illustrate some of the fundamental notions and concepts of this theoretical framework (place of emotions in decision-making, *significations imaginaires*, self-narrative), we designed an immersive experiment that immerses learners in an absurd environment, in which they make a series of choices followed by a decision. This shows that every individual makes sense of what he or she experiences by putting together the signs captured in his or her environment. The exercise aims to raise awareness that we create meaning in any situation, normal or abnormal, based on our subjectivation. This creation of meaning is part of our self-narrative. In return, the self-narrative allows the adhesion and the self-adhesion to the subjectively created meaning. Current scope of application of the device is limited to initial training of safety managers but it is likely to be extended in the near future to continuing education for crisis managers or emergency response teams. The first results of this experiment led us to identify areas of development for the device and its pedagogical supports we are willing to develop within a 3-5 years research program addressed by a multidisciplinary team.

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